# GENERATING CYCLES OF PRODUCTS AND PRICES


## SUMMARY

The major features of economic cycles are traceable to three primary laws: (1) the law of the generating cycle of raw materials, which is due to a non-economic cause; (2) the law of demand for raw materials, in consequence of which the generating cycle of products originates a derived cycle of prices for raw materials; and (3) the law of competitive price, according to which the prices of finished goods in an open market tend to correspond with the cost of production.

Correlation of crop yields and crop prices, 218. — Generating cycles of products, 224. — The derived cycle of prices, 226. — Cycles in the products of mines, 228. — Cycles in raw materials, 231. — Concluding observations, 233.


A TELLING advance was made in the theory of economic dynamics when crises were proved to be phases of economic cycles. The spectacular features of crises — panics, bankruptcies, collapse of prices, unemployment of labor, and subsequent general depression of business — had for some time attracted attention and elicited innumerable theories as to their cause. A general characteristic of these theories was the citing of detached, non-recurring events as the separate cause of each isolated crisis. A war, a failure of some conspicuous establishment, an election, or a bad harvest were among the supposed causes. With the development of the theory of cycles the well-marked stages of prosperity, crisis, decline, and depression were described and shown to be parts of a general rhythm of industry. This more ample view of the vicissitudes of business suggested that if the rhythm as a whole could be traced to a single cause, the foundation would be laid for long-range forecasting and would, perhaps, lead to the con-

trol of economic changes in the interest of the social good.

The buoyant, expectant hope which stimulated the early searchers for a single, persistent cause of cycles is shared by few recent investigators. On the contrary, there is flat denial of the existence of any marked regularity or periodicity in the phenomena; attempts at explanation by means of a few causes are regarded as obsolete; and while recognition is made of the existence of the cycle with its separate phases, there is, in many cases, a reversion to the method of alleging isolated, separate explanations for each critical point in the several phases. The present inquiry takes up the abandoned search for a single explanation of the entire rhythm and its constituent parts.

Two accomplished investigators, Professor Aftalion,[1] and Professor Bresciani-Turroni,[2] have pointed out that the average length of cycles, since 1857, has been in the neighborhood of eight years. That fact is sufficient reason for asking why cycles are, on the average, about eight years in length, and whether this loose periodicity may not have as its origin a periodically recurring cause. Professor Mitchell, in his masterly *Business Cycles*, has set in relief another fact of critical significance, namely, the supreme importance in each phase of the cycle of the volume and prices of raw materials. In his description of "How Prosperity Breeds a Crisis" he has made an illuminating statement which is here quoted at length. I have taken the liberty of italicizing several sentences:

> . . . The cost of materials exceeds wages in every one of the leading branches of manufacture, and in a majority of cases is over twice

[1] Albert Aftalion, Les Crises périodiques de surproduction, vol i, p v, vol. ii, pp. 32, 33, and *passim*.

[2] Costantino Bresciani-Turroni, Le Variazioni cicliche dei prezzi, p 57.

as large. Indeed, on the average it makes practically two-thirds of the total outlay. If wares for re-sale be substituted for materials, this proportion must run far higher in wholesale stores, while in retail shops it cannot be much lower than in factories on the average and may well be considerably higher. Even the transportation companies and enterprises in the extractive industries have to buy vast quantities of current supplies. Hence an increase in the cost of materials, wares, or supplies is often an increase in the largest single item of expense, and always an increase in an important item. The relative fluctuations in the prices of those commodities which are bought and of those which are sold are therefore of great, in many cases of decisive, importance in determining profits.

Concerning these relative fluctuations, our definite information consists of index-numbers for raw materials, partially manufactured products, and finished goods; also for the same commodities at wholesale and at retail. Now this statistical evidence points to the conclusion that what must be taken as buying prices creep up on selling prices during a period of prosperity. Of course this movement . . . threatens a reduction of profits.

*While a difficulty of this character seems to be encountered in most branches of business it is likely to become peculiarly acute in those manufacturing industries which use animal and farm products as their leading raw materials.* For, following up a suggestion of Sombart's, we have found that these classes of products are more erratic in their price fluctuations than are the products of mines and forests. Hence an uncommonly large speculative risk must be borne, or insured against, in such branches of trade as meat packing, flour milling, cotton spinning, woollen weaving, tanning, etc. Of course this risk exists during all phases of the business cycle, but it is augmented in prosperity by the necessity of carrying larger stocks of raw materials. *The census indicates that more than three-fourths of all the "materials purchased in the raw state" by American factories in 1900 belonged to this class which is peculiarly unstable in price.*[1]

[1] W. C. Mitchell, Business Cycles, pp. 481, 482. To the above statement Professor Mitchell appends the following note, p. 482, note 10.

"The sources of raw materials are given as follows:

| | |
|---|---|
| From farms | $1,941,000,000 |
| " forests | 119,000,000 |
| " mines | 320,000,000 |
| " the sea | 10,000,000 |
| " all sources | $2,490,000,000 |

Twelfth Census of the United States, Manufactures, Part I, p. cxxxv."

There is a slight error in the above value "from all sources." The aggregate sum is $2,390,000,000, and this would make the proportion contributed by the farms 81.2 per cent.

Now may it not be that the physical yield of the farms, which supplied more than three-fourths of all the raw materials of American factories in 1900, is itself a periodically varying magnitude that will produce a corresponding rhythm in the prices of raw materials and the prices of products derived therefrom? Is it not possible that this same periodicity may be of such length as to approximate the average length of cycles which has been noted by Professor Aftalion and Professor Bresciani-Turroni?

If we discover this periodicity in the yield of farm products, we shall make a distinction between generating economic cycles and derived economic cycles. Generating economic cycles will then be economic cycles which have their origin in non-economic causes and are themselves the originating source of derived economic cycles. If the varying yield of the crops has its origin in a periodic meteorological cause, it will itself be periodic and will generate periodic sequences in the whole of the dependent economic changes. If the existence of such a generating cycle is established, there will be no need, in treating the phases of economic cycles, to seek separate explanations for their existence. The phases of the generating cycles will themselves originate corresponding phases in the dependent, derived cycles.

## The Correlation of Crop Yields and Crop Prices

From the point of view of the value of the product, our crops ranked, in 1919, in the following order: corn, wheat, cotton, hay, oats, potatoes. These six crops, in 1919, contributed 70.8 per cent of the value of the multitudinous crops produced by our farms. The aggregate

value of all the crops produced in 1919 was, according to the estimate [1] of the Secretary of Agriculture, $15,873,000,000, and of this aggregate amount the above six products contributed $11,238,536,000. The records of the yields and prices of these six crops from 1882 give the statistical material of which use is made in the subsequent investigation.

As the American production in case of all six of these commodities is only a part of the world supply, our first inquiry will be whether, notwithstanding this fact, the domestic prices are immediately related to the domestic yield. Furthermore, as we wish to eliminate the varying factor of changing acreage, our inquiry will take the form of ascertaining whether the domestic prices of these several crops are immediately related to the respective yields per acre.

In order to secure a certain degree of comparability in the graphs, the raw figures [2] of yield and the corresponding December farm price were, for each crop, converted into index numbers in which the average yield and the average price for the years 1890–99 were taken as the respective bases. The graphs of these index numbers of yield and prices are given in Figures 1, 2, 3. In each of the six graphs of yield and the six graphs of prices the statistics show a secular trend which must be ascertained as a preliminary to the work of finding the relation between the variations in yield and the variations in prices. In each of the twelve curves the secular trend was obtained by fitting a curve of the type $y = a + bx + cx^2 + dx^3$ to the data, and the resulting equations were found to be those that are given in the descriptions of Figures 1, 2, and 3. The origins of the equations are different in the two graphs, because the

[1] Yearbook of the Department of Agriculture, 1919, p 17

[2] The raw figures of yield per acre and December farm prices were taken from the Yearbooks of the Department of Agriculture

crops are taken from 1880 to 1918, and the prices, owing to the abnormal fluctuations during the war, only from 1880 to 1914.

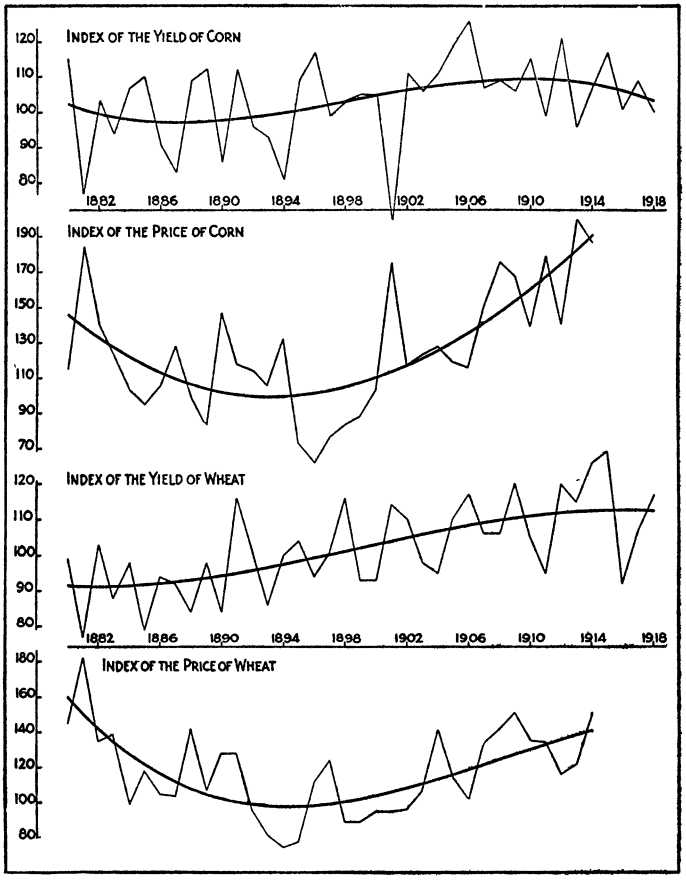


FIGURE 1

Secular trends in the index numbers of the yield and price of corn and wheat.

Corn: Yield, $y = 103\ 9 + 838x - 0032x^2 - 002{,}233x^3$, origin at 1899;
Price, $y = 102.4 + 1\ 690x + .2275x^2 - 001{,}288x^3$, origin at 1897.

Wheat. Yield, $y = 102\ 1 + 952x - .0004x^2 - .001{,}101x^3$, origin at 1899,
Price, $y = 99\ 2 + 1.057x + .1780x^2 - .005{,}570x^3$, origin at 1897.

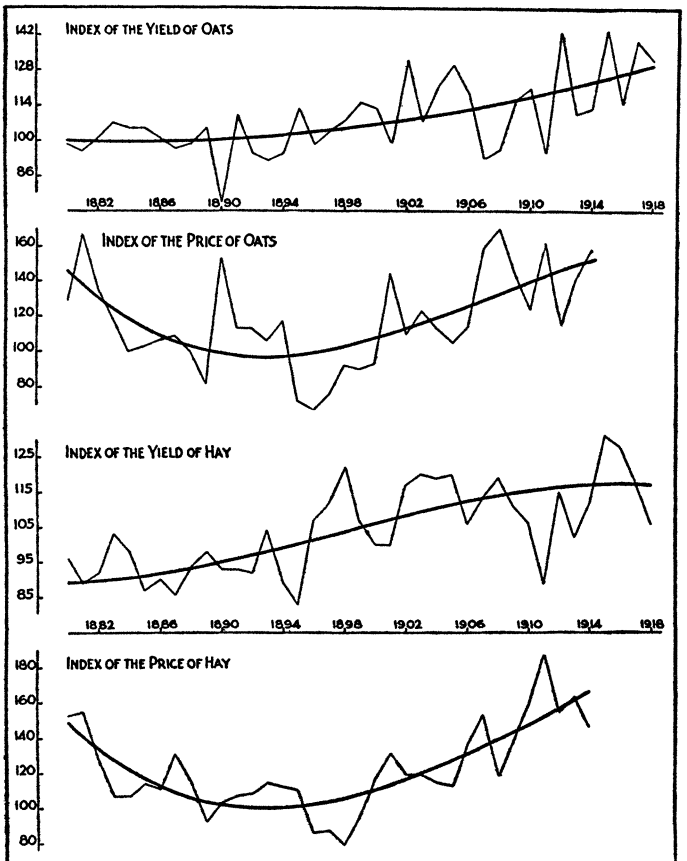


FIGURE 2

Secular trends in the index numbers of the yield and price of oats and hay.

Oats: Yield, $y = 105\,7 + 805x + 0258x^2 - .000{,}038x^3$, origin at 1899;
Price, $y = 100\,6 + 1\,700x + .1692x^2 - 005{,}271x^3$, origin at 1897.

Hay: Yield, $y = 104\,9 + 1\,156x - 0049x^2 - 001{,}816x^3$, origin at 1899;
Price, $y = 103\,1 + 1\,696x + 1882x^2 - .004{,}042x^3$, origin at 1897.

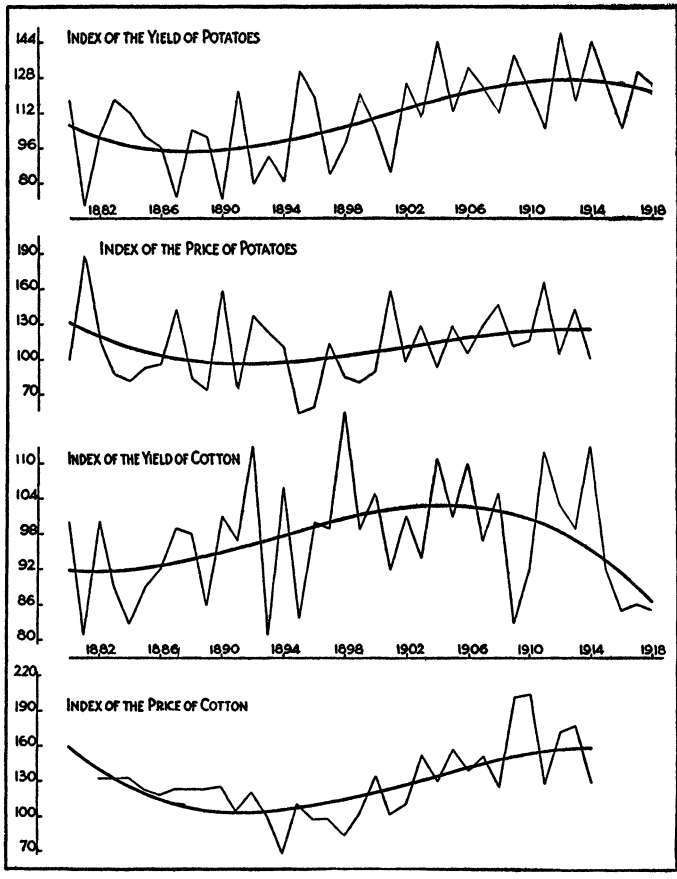


FIGURE 3

Secular trends in the index numbers of the yield and price of potatoes and cotton.

Potatoes. Yield, $y = 108\ 2 + 1.992x + .0179x^2 - .004{,}435x^3$, origin at 1899;
Price, $y = 101\ 6 + 1.612x + .0921x^2 - 006{,}101x^3$, origin at 1897.
Cotton: Yield, $y = 101.2 + .548x - .0331x^2 - .001{,}901x^3$, origin at 1899,
Price, $y = 111\ 0 + 2\ 688x + .1667x^2 - 009{,}536x^3$, origin at 1897

The next step in the inquiry is to determine whether the percentage variations of the yields of the several crops from their respective secular trends are related to the corresponding percentage variations of prices from the respective secular trends of prices. The method of investigation will be made clearer by an illustration. The equation descriptive of the secular trend in the yield of corn was found to be $y = 103.9 + .838x - .0032x^2 - .002{,}233x^3$ with origin at 1899. The graph of this equation is the smooth curve in the upper part of Figure 1. The equation descriptive of the secular trend of the December farm price of corn was found to be $y = 102.4 + 1.690x + .2275x^2 - .001{,}288x^3$, with origin at 1897, the graph of which is also given in Figure 1. The percentage deviations from the secular trend of the actual yield per acre for the separate years from 1880 to 1914 were computed, and these percentage deviations were then correlated with the corresponding percentage deviations of the actual prices from the price secular trend. Table I in the Appendix, which refers to corn, gives an illustration of the computations. Similar calculations were made for the remaining five crops, and the coefficients of correlation between the corresponding percentage deviations, for the years 1880–1914, were computed. The resulting coefficients were these:

| | |
|---|---|
| Corn | $r = -.78$ |
| Wheat | $r = -.23$ |
| Cotton | $r = -.45$ |
| Hay | $r = -.68$ |
| Oats | $r = -.67$ |
| Potatoes | $r = -.90$ |

Notwithstanding the fact that the American production of these crops is only a part of the world supply, there is an inverse relation between the percentage deviations of the yield per acre of our crops and the percentage deviations of the corresponding prices.

## Generating Cycles of Products

We have just established that there is an inverse relation between the yield per acre of each of the six representative crops and their respective prices. If now we can show that the combined yield of the crops is periodic, there will be excellent reason for believing that their combined prices will be periodic and that the prices of commodities produced from farm materials will tend to show the same well-defined rhythm. Our immediate problem, therefore, is to discover whether there is a periodic cycle in the combined yield of the six representative crops.

To go forward with the work we needed to compute an index number of the combined yield of the representative crops. In treating the preceding question as to the correlation of the yield of the several crops with their respective prices, we computed, in each case, the percentage deviations of the yield per acre from the secular trend. For our present purpose of finding whether the combined yield of the six crops tends to run in cycles, the percentage deviations of the yield of the several crops for each year of the record, from 1882 to 1918, were added. The resulting figures, which are given in Table II of the Appendix, constitute our index numbers of the yield per acre of the six crops

In the attempt to learn whether, during the interval under investigation, the yield of the crops was cyclical and periodic, the periodogram of the yield was computed and the graph was drawn. The results of the computation are given in Table III of the Appendix, and the graph appears at the top of Figure 4. The periodograph shows that if there is a periodicity between three and twelve years in the data, its most prob-

able length is in the neighborhood of eight years. When the probable period of eight years is computed, its maxima are found to occur, approximately, at 1882, 1890, 1898, 1906, 1914. The graph of the eight-year cycle is given in the lower part of Figure 5. This outcome of the calculations is gratifying because of its consonance with results that have already been obtained.

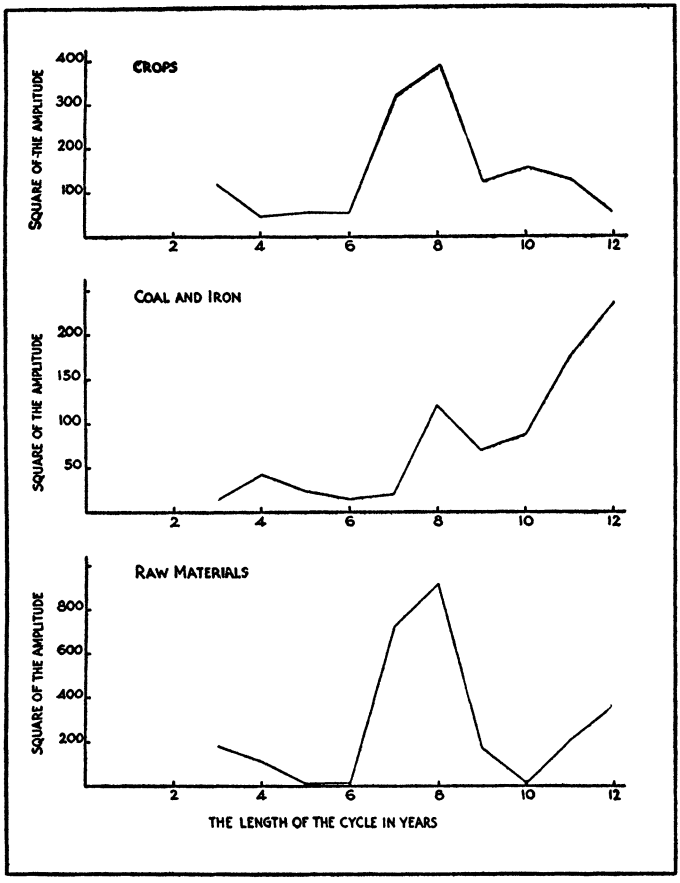


FIGURE 4
Periodographs of crops, coal and iron, and raw materials of manufacture

Other investigations [1] have shown that there are eight-year cycles with maxima approximately at 1882, 1890, 1898, 1906, 1914 in the annual rainfall of the Ohio Valley, the May and June rainfall of the Dakotas, and in the yield of wheat, oats, and barley in the Dakotas, the United States, the United Kingdom, and France.

## The Derived Cycle of Prices

We have just described the construction of an index number of the combined yield of the six crops by summing the percentage deviations of the yields from their respective secular trends. To carry the inquiry beyond the stage that was reached in the last section an index number of the combined prices of the six crops was constructed by summing, for each year, the percentage deviations of the prices of the several crops from the respective secular trends of prices. The data are given in Table IV of the Appendix. These two index numbers — the index of the combined yield and the index of the combined prices — supplied the material for the next stage in the problem, namely, to ascertain the degree of relation between the variations in the index of the combined yield and the index of the combined prices.

The coefficient of correlation between these two variables is $r = -.69$, and the equation expressing their relation is $y = -1.295x - .02$, where $x =$ the index of the yield and $y =$ the index of prices. This close relation indicates that the eight-year cycle in the yield per acre of the crops tends to generate an eight-year cycle in the prices of the products. Figure 5 shows, in its upper half, the course of the index number of actual prices and the course of the theoretical index when $y =$

[1] "Forecasting the Crops of the Dakotas," Political Science Quarterly, June, 1919, pp. 228, 229. "Crop Cycles in the United Kingdom and in the United States," Journal of the Royal Statistical Society, May, 1919. "Crop Cycles in the United Kingdom and in France," ibid., May, 1920.

$-1.295x - .02$ is used as a forecasting formula. The lower half of Figure 5 shows the generating eight-year cycle in the yield per acre of the crops and the derived eight-year cycle in the prices of the crops. The equation of the generating cycle of products was obtained in the preceding section. The derived cycle of prices was computed from the generating cycle of products by

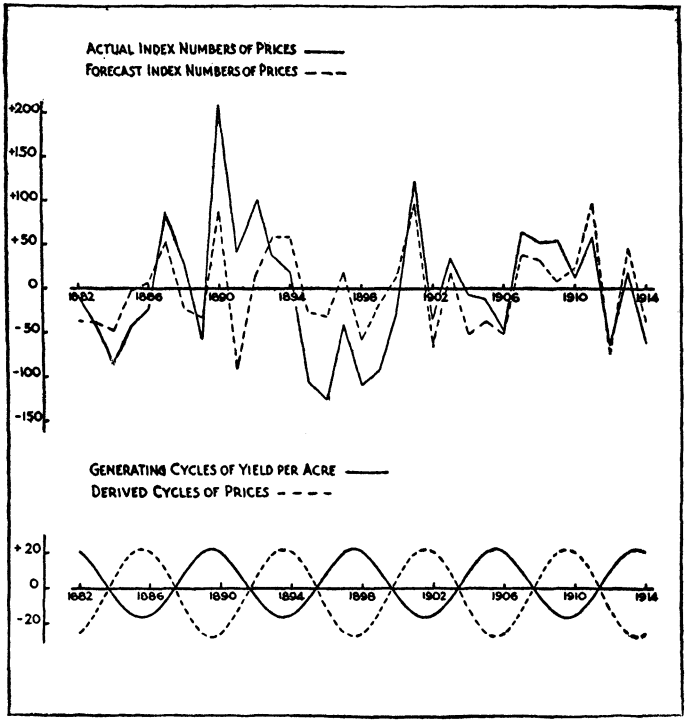


FIGURE 5

Upper part: Actual index numbers of prices of the six representative crops and the index numbers of prices forecast from the index numbers of the yield per acre by means of the formula

$$y = -1.295x - .02.$$

Lower part: Generating cycles of the yield per acre of the crops,

$y = 1.6 + 20.0 \sin (45°t + 109°)$, origin at 1882;

Derived cycles of prices of the crops computed from the generating cycles of yield by means of the formula,

$$y = -1.295x - .02.$$

means of the formula connecting the variations of the combined yield with the variations of the combined prices. ($y = -1.295x - .02$.)

## Cycles in the Products of Mines

We have noted that according to the census of 1900, the values of raw materials used in manufactures were as follows: from farms, $1,941,000,000; from forests, $119,000,000; from mines $320,000,000; from the sea $10,000,000. Of the aggregate value of these materials, 81.2 per cent was supplied by the farms; 5.0 per cent by the forests; 13.4 per cent by the mines; and 0.4 per cent by the sea. We have already shown that the yield of the leading farm crops moves in well-defined cycles which generate corresponding cycles of agricultural prices. The leading crops upon which the computation was based supplied 70 per cent of the total value of American crops in 1919 and are therefore sufficiently representative of the yield and prices of farm products. Next to the farms, according to the above figures, the mines furnish the most important source of materials for manufactures. The farms and the mines together supplied, in 1900, 94.6 per cent of the value of the raw materials used in American factories. Does the production of minerals move in cycles ?

The most important minerals for the use of manufactures and transportation are coal and iron, and in our further inquiry these two minerals will be regarded as being representative of the products of the mines just as the six crops — corn, wheat, oats, hay, cotton, and potatoes — were treated as being representative of the products of the farm.

In preparing the statistics of the production of coal and pig iron with a view to ascertaining whether there is

any periodicity in their production, the procedure was similar to that which was followed in the case of the yield of the crops. The raw figures [1] of production were first reduced to index numbers in which the mean production for 1890–99 was placed as equal to 100. The graphs of the index numbers of production are given in Figure 6. Because of the enormous and irregular increase in the production of both coal and iron in the interval under investigation, 1881–1913, the description of the secular trends by means of single equations requires the use of a slightly more complex curve than the one employed in the treatment of the yield and prices of farm products. In the latter case a parabola of the type $y = a + bx + cx^2 + dx^3$ was found to give a satisfactory fit. But in the description of the secular trends in the production of coal and iron an additional term was added to the above equation, and a parabola of the fourth order $y = a + bx + cx^2 + dx^3 + ex^4$ was fitted to the data. The graphs in Figure 6 show the secular trend of both coal and iron, and the corresponding equations are given in the legend descriptive of Figure 6.

After the secular trend of coal and the secular trend of iron were ascertained, the percentage deviations of the production of each commodity in the years from 1882–1913 were computed. These percentage deviations were then combined into an index number of the deviations in the production of coal and iron by summing the percentage deviations for each year. The data are given in Table V of the Appendix. Because of the abnormal demand for coal and iron during the war the figures were not extended beyond 1913.

If now the index numbers of the deviations in the production of coal and iron from 1882 to 1913 are scru-

[1] The figures were taken from the Statistical Abstract of the United States, 1915, pp 689, 690

tinized with a view to discovering periodicities, we find that the periodograph takes the shape that is pictured in the second curve in Figure 4. The data are given in Table III of the Appendix.

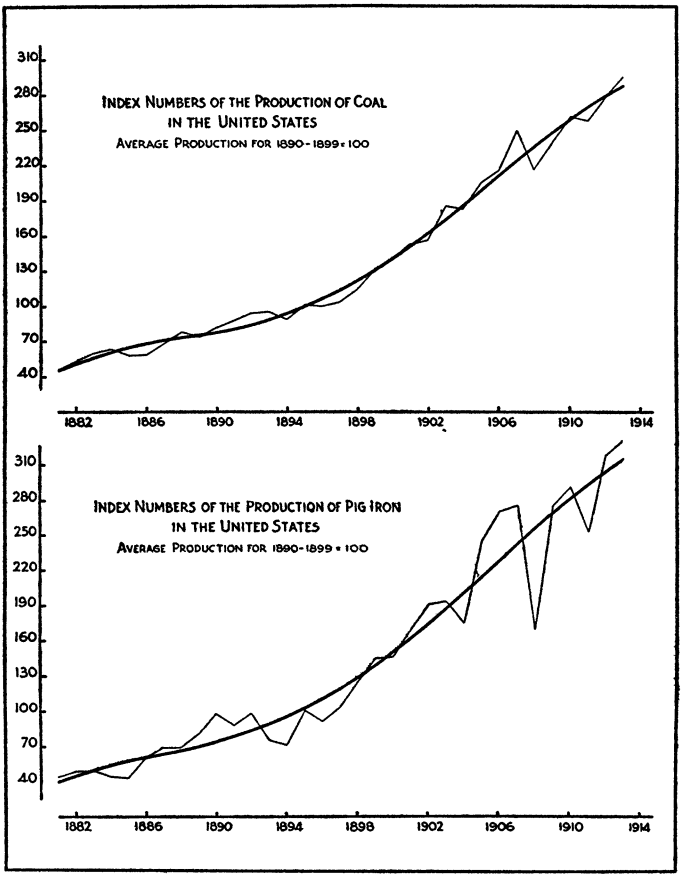


FIGURE 6

Secular trends in the index numbers of the production of coal and pig iron in the United States.

Coal: $y = 114.1 + 7.777x + .4131x^2 - 000{,}751x^3 - .000{,}8141x^4$, origin at 1897;

Pig Iron: $y = 119.4 + 9.199x + .4110x^2 - .002{,}561x^3 - .000{,}7239x^4$, origin at 1897.

It is obvious from the periodograph that if there are real cycles in the production of coal and iron, the most probable are in the neighborhood of eight and eleven or twelve years in length, but in the present paper we shall confine the discussion to the eight-year cycle. When the equation to the eight-year cycle is computed, the maxima are found to occur approximately at 1882, 1890, 1898, 1906, 1914. And if the eight-year cycle in the production of coal and iron is graphed and compared with the graph of the eight-year cycle in the yield of the crops, the coal and iron curve is found to lag about three-tenths of a year behind the curve for the crop yield. The graphs are given at the top of Figure 7.

## Cycles in the Production of the Raw Materials of Manufacture

The production of the farms and the mines taken separately tends to run in eight-year cycles, the cycles of the raw materials from the mines inclining to lag a few months behind the cycles in the yield of the crops. The farms and the mines together supplied, in 1900, 95 per cent of the raw materials of American factories, and, consequently, their joint production affords both an adequate measure of the changes in the volume of raw materials and a valuable index of the changes in the physical volume of trade. Is there any regularity in the joint production of the farms and the mines ?

In the same manner in which we constructed an index number of the yield of the crops and an index number of the production of coal and iron, we made an index number of the raw materials of manufacture. The percentage deviations of the yield of the crops and the percentage deviations of the production of coal and iron were summed, and the aggregate percentage deviations

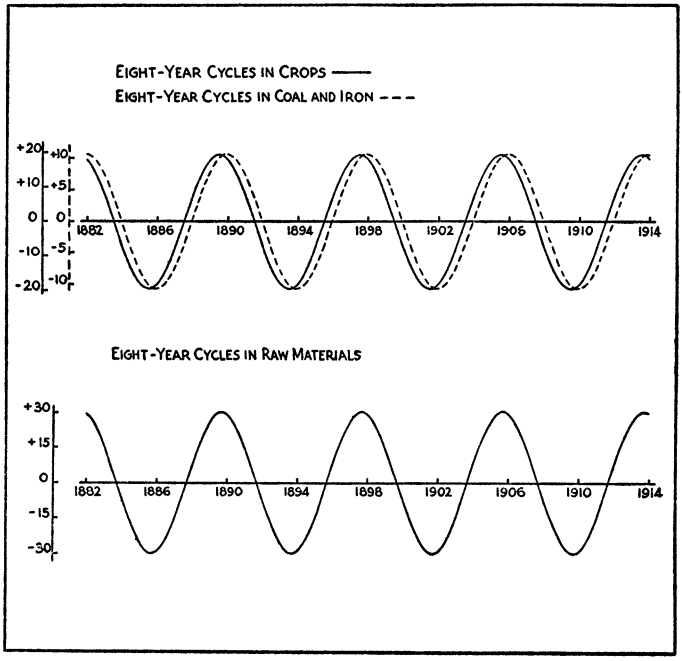


FIGURE 7

Cycles in the yield of the crops, the production of coal and iron, and the production of the raw materials of manufacture

Crops $y = 20\ 0 \sin (45°t + 109°)$, origin at 1882,
Coal and Iron $y = 11\ 0 \sin (45°t + 93°)$, origin at 1882,
Raw Materials $y = 30\ 3 \sin (45°t + 103°)$, origin at 1882

were regarded as the index numbers of the production of raw materials. The data are given in Tables II and V of the Appendix.

When the index numbers of raw materials from 1882 to 1913 were scrutinized for the purpose of discovering periodicities, it was found that the periodograph took the shape of the bottom curve in Figure 4, showing that if there is a cycle in the production of raw materials of manufacture in the United States, its probable length is about eight years. The computations referring to the periodograph are given in Table III of the Appendix. If

the eight-year cycle in the production of the raw materials of manufacture is computed, its maxima will occur, approximately, at 1882, 1890, 1898, 1906, 1914, and the graph of the cycle will run in the manner described in the bottom curve of Figure 7.

There are two observations with regard to the theory of economic cycles that need to be emphasized by frequent repetition. The first was made by Professor Aftalion, the second by Rodbertus.

After estimating the average length of cycles since 1857 at approximately eight years, Professor Aftalion stated that the essential problem in the theory of economic cycles is to discover the cause of the rhythm. "L'observation du rythme de la production générale fait . . .seulement comprendre la *survenance* d'une hausse, puis d'une baisse générale des prix, l'existence d'un rythme. Elle ne nous donne pas l'explication de la *durée* de cette hausse ni de cette baisse, de la durée des phases du rythme." [1]

In one of the briefer essays of Rodbertus, "Physiokratie und Anthropokratie," [2] the initiator of the socialist theory of business cycles stresses the importance of discovering the natural cause of the economic rhythm in order that society may set about adjusting itself in the light of the acquired knowledge. He draws the distinction between the rule of nature — Physiokratie — and the rule of man — Anthropokratie. Quesnay and Adam Smith and their followers, according to Rodbertus, regarded the problems of social science primarily from the point of view of physical science and were led to the maxim "*laissez aller et laissez passer; le monde va de lui-même.*" By contrast Rodbertus would empha-

[1] Albert Aftalion, Les Crises périodiques de surproduction, vol. II, pp 41, 42.

[2] Rodbertus-Jagetzow, Briefe und Socialpolitische Aufsätze

size the great possibilities of social progress through the intervention of the state and the utilization of natural laws for social purposes. With regard to the specific problem of economic cycles, the natural law and cause of the rhythm must be discovered and then utilized by society for its own ends. "Sich im Staatsleben Naturgesetzen zu unterwerfen, heisst, sich des 'Göttlichen' im Menschen begeben, heisst, von socialen Organismen, muthwillig in Krankheit und Tod gehen.

Nach ewigen, eh'rnen
Grossen Gesetzen
Müssen wir Alle
Uns'res Daseins
Kreise vollenden.
Nur allein der Mensch
Vermag das Unmögliche;
Er unterscheidet,
Wählet und richtet;
. . . . . .
Er allein darf
. . . . . .
Alles Irrende, Schweifende
Nützlich verbinden."

Goethe: *Das Göttliche.*

HENRY LUDWELL MOORE.

COLUMBIA UNIVERSITY.

# APPENDIX

TABLE I. — CORRELATION OF THE PERCENTAGE DEVIATIONS OF THE PRICE OF CORN WITH THE PERCENTAGE DEVIATIONS OF THE YIELD PER ACRE OF CORN

| Year | Index number of the yield of corn | General trend of the yield of corn | Percentage deviation from the trend | Index number of the price of corn | General trend of the price of corn | Percentage deviation from the trend |
|---|---|---|---|---|---|---|
| 1880 | 114 | 102 | +11.8 | 115 | 146 | −21.2 |
| 1881 | 77 | 101 | −23.8 | 184 | 139 | +32.4 |
| 1882 | 102 | 100 | + 2.0 | 141 | 133 | + 6.0 |
| 1883 | 94 | 99 | − 5.1 | 123 | 127 | − 3.1 |
| 1884 | 107 | 98 | + 9.2 | 103 | 122 | −15.6 |
| 1885 | 110 | 98 | +12.2 | 95 | 117 | −18.8 |
| 1886 | 91 | 97 | − 6.2 | 106 | 113 | − 6.2 |
| 1887 | 83 | 97 | −14.4 | 129 | 110 | +17.3 |
| 1888 | 109 | 97 | +12.4 | 99 | 107 | − 7.5 |
| 1889 | 112 | 97 | +15.5 | 82 | 104 | −21.2 |
| 1890 | 86 | 98 | −12.2 | 147 | 102 | +44.1 |
| 1891 | 112 | 98 | +14.3 | 118 | 101 | +16.8 |
| 1892 | 96 | 99 | − 3.0 | 114 | 100 | +14.0 |
| 1893 | 93 | 99 | − 6.1 | 106 | 99 | + 7.1 |
| 1894 | 80 | 100 | −20.0 | 132 | 99 | +33.3 |
| 1895 | 109 | 101 | + 7.9 | 73 | 100 | −27.0 |
| 1896 | 117 | 101 | +15 8 | 62 | 101 | −38.6 |
| 1897 | 99 | 102 | − 2.9 | 76 | 102 | −25.5 |
| 1898 | 103 | 103 | 0.0 | 83 | 104 | −20.2 |
| 1899 | 105 | 104 | + 1.0 | 88 | 107 | −17.8 |
| 1900 | 105 | 105 | 0.0 | 103 | 109 | − 5.5 |
| 1901 | 69 | 106 | −34.9 | 175 | 113 | +54.9 |
| 1902 | 111 | 106 | + 4.7 | 117 | 116 | + 0.9 |
| 1903 | 106 | 107 | − 0.9 | 123 | 120 | + 2.5 |
| 1904 | 111 | 108 | + 2.8 | 128 | 125 | + 2.4 |
| 1905 | 120 | 108 | +11.1 | 119 | 130 | − 8.5 |
| 1906 | 126 | 109 | +15.6 | 116 | 135 | −14.1 |
| 1907 | 108 | 109 | − 0.9 | 150 | 141 | + 6.4 |
| 1908 | 109 | 110 | − 0.9 | 176 | 147 | +19.7 |
| 1909 | 106 | 110 | − 3.6 | 168 | 153 | + 9.8 |
| 1910 | 115 | 110 | + 4 5 | 139 | 160 | −13.1 |
| 1911 | 99 | 110 | −10.0 | 179 | 167 | + 7.2 |
| 1912 | 121 | 109 | +11.0 | 141 | 175 | −19.4 |
| 1913 | 96 | 109 | −11.9 | 200 | 182 | + 9.1 |
| 1914 | 107 | 108 | − 0.9 | 187 | 191 | − 2.1 |

TABLE II. — INDEX NUMBERS OF THE YIELD PER ACRE OF SIX CROPS

| Year | Percentage deviations from the respective trends of the index numbers of yield per acre | | | | | | Combined index number |
|---|---|---|---|---|---|---|---|
| | Corn | Wheat | Oats | Potatoes | Hay | Cotton | |
| 1882 | + 2.4 | +12.9 | + 1.1 | + 1.0 | + 2.9 | + 8.7 | +29.0 |
| 1883 | − 4.7 | − 3.7 | + 7.7 | +19.2 | +14.6 | − 3 3 | +29.8 |
| 1884 | + 9 2 | + 7.8 | + 5.0 | +15.5 | + 8.8 | − 9.8 | +36.5 |
| 1885 | +12.5 | −14.1 | + 5.7 | + 5.2 | − 3.8 | − 3.3 | + 2 2 |
| 1886 | − 6.3 | + 2.0 | + 1.1 | + 1.1 | − 2 0 | − 1.1 | − 5 2 |
| 1887 | −14.1 | − 0.9 | − 2.9 | −22.1 | − 7.0 | + 6.4 | −40.6 |
| 1888 | +12.1 | − 9.6 | − 0.8 | +10.6 | + 1.4 | + 4.3 | +18.0 |
| 1889 | +15.0 | + 4.4 | + 4.3 | + 6,3 | + 4.7 | − 8.5 | +26.2 |
| 1890 | −12.1 | −10.8 | −25 0 | −23.2 | − 2.1 | + 6.3 | −66.9 |
| 1891 | +14.2 | +22.0 | + 9.4 | +27.1 | − 2.9 | + 1.0 | +70.8 |
| 1892 | − 2.7 | + 5.9 | − 8.1 | −17.5 | − 4.9 | +17.7 | − 9.6 |
| 1893 | − 5.8 | −10.6 | −12.3 | − 6.1 | + 6.0 | −16.5 | −45.3 |
| 1894 | −19.4 | + 2.6 | − 8.6 | −18.2 | −10.1 | + 8.2 | −45.5 |
| 1895 | + 8.1 | + 5.5 | + 9.8 | +29.7 | −17.4 | −15.2 | +20.5 |
| 1896 | +15.4 | − 5.4 | − 5.2 | +15.5 | + 5.5 | + 1.0 | +26.8 |
| 1897 | − 3.3 | + 1.3 | − 0.4 | −19.2 | + 8.9 | − 1.0 | −13.7 |
| 1898 | − 0.2 | +14.5 | + 3.3 | − 7.5 | +16.8 | +17.8 | +44.7 |
| 1899 | + 1.1 | − 8.7 | + 9.1 | +12.0 | + 2.0 | − 2.0 | +13.5 |
| 1900 | + 0.3 | − 9.6 | + 6.1 | − 4.5 | − 5.7 | + 2.9 | −10.5 |
| 1901 | −34.4 | + 9.2 | − 8.3 | −24.1 | − 6.7 | − 9.8 | −74.1 |
| 1902 | + 4.6 | + 4.7 | +21.6 | + 9.6 | + 8.2 | − 1.1 | +47.6 |
| 1903 | − 1.2 | − 7.7 | − 0.8 | − 5.2 | +10.0 | − 8.7 | −13.6 |
| 1904 | + 3 3 | −11.2 | +11.0 | +22.0 | + 7.5 | + 7.8 | +40.4 |
| 1905 | +10.3 | + 2.0 | +16.5 | − 5.8 | + 8.0 | − 1.9 | +29.1 |
| 1906 | +15.4 | + 8.3 | + 5.8 | + 9.0 | − 6.1 | + 6.8 | +39.2 |
| 1907 | − 1.6 | − 2.8 | −20.5 | + 0.8 | + 0.1 | − 4.9 | −28.9 |
| 1908 | − 0 8 | − 3.5 | −17.0 | − 9.7 | + 4.1 | + 2.9 | −24.0 |
| 1909 | − 3.6 | + 8.3 | − 0.6 | +10.4 | − 3.4 | −17.8 | − 6.7 |
| 1910 | + 4.6 | − 5.1 | + 2.6 | − 3.2 | − 8.0 | − 8.9 | −18.0 |
| 1911 | − 9.5 | −15.1 | −21.8 | −17.3 | −23 2 | +12.0 | −74.9 |
| 1912 | +10.9 | + 7.6 | +18.5 | +16.5 | − 1.5 | + 5.1 | +57.1 |
| 1913 | −11.9 | + 2.6 | − 8 5 | − 7.1 | −12.4 | + 2.1 | −35.2 |
| 1914 | − 1.0 | +11.7 | − 8.1 | +13.4 | − 4.7 | +18.9 | +30.2 |
| 1915 | + 8.9 | +14.3 | +15.4 | − 0.8 | +11.9 | − 2.1 | +47.6 |
| 1916 | − 4.8 | −18 6 | − 9 2 | −16.0 | + 9.2 | − 6.6 | −46.0 |
| 1917 | + 4.0 | − 5.2 | + 8.9 | + 5.6 | + 0.7 | − 3.4 | +10.6 |
| 1918 | − 3.7 | + 4.4 | + 1.6 | + 2.5 | − 9 2 | − 2.3 | − 6.7 |

TABLE III. — PERIODOGRAMS OF THE INDEX NUMBERS OF THE YIELD PER ACRE OF THE CROPS, THE PRODUCTION OF COAL AND IRON, AND THE PRODUCTION OF THE RAW MATERIALS OF MANUFACTURE

| Length of the cycle (years) | Square of the amplitude | | |
|---|---|---|---|
| | Crops | Coal and iron | Raw materials |
| 3 | 148.65 | 14.12 | 182.17 |
| 4 | 41.15 | 42.37 | 110.64 |
| 5 | 67.18 | 24.41 | 5.92 |
| 6 | 65.20 | 13.13 | 11.45 |
| 7 | 319 21 | 21.03 | 725.32 |
| 8 | 401.24 | 120.41 | 919.26 |
| 9 | 123.92 | 70.41 | 170.32 |
| 10 | 155.16 | 87.49 | 16.42 |
| 11 | 129.95 | 176.26 | 211.03 |
| 12 | 54.31 | 237.70 | 368.68 |

TABLE IV. — INDEX NUMBERS OF THE DECEMBER FARM PRICES OF SIX CROPS

| Year | Percentage deviations from the respective trends of the index numbers of the December farm prices | | | | | | Combined index number |
|---|---|---|---|---|---|---|---|
| | Corn | Wheat | Oats | Potatoes | Hay | Cotton | |
| 1882 | + 6.0 | − 4.9 | + 3.1 | − 2.5 | − 4.5 | − 5.7 | − 8.5 |
| 1883 | − 3.1 | + 3 0 | − 4.8 | −22.8 | −15.7 | 0.0 | − 43.4 |
| 1884 | −15.6 | −22.7 | −16.0 | −25.5 | −12.3 | + 6.4 | − 85.7 |
| 1885 | −18.8 | − 3.3 | − 9.6 | −12.3 | − 2.6 | + 2.5 | − 44.1 |
| 1886 | − 6.2 | −10.3 | − 1.8 | − 5.8 | − 1.8 | + 2 6 | − 23.3 |
| 1887 | +17.3 | − 7.1 | + 2.8 | +40.6 | +20.2 | +11.8 | + 85.6 |
| 1888 | − 7.5 | +31.5 | − 2.9 | −15.2 | + 8.5 | +14.9 | + 29.3 |
| 1889 | −21.2 | + 1 9 | −18.8 | −24.5 | −11.5 | +17.1 | − 57 0 |
| 1890 | +44.1 | +25.5 | +54.5 | +62.9 | + 1.0 | +20.1 | +208.1 |
| 1891 | +16.8 | +26.7 | +15.3 | −23.7 | + 6.0 | + 1.0 | + 42.1 |
| 1892 | +14.0 | − 4.0 | +16.5 | +41.2 | + 8.0 | +16.5 | + 92.2 |
| 1893 | + 7.1 | −16.3 | + 9.3 | +26.8 | +14.0 | − 2.9 | + 38.0 |
| 1894 | +33.3 | −23.5 | +20.6 | +13.3 | +12.0 | −36.2 | + 19.5 |
| 1895 | −27.0 | −20.4 | +26.5 | −44.4 | + 9.0 | + 3.8 | −105.5 |
| 1896 | −38.6 | +13.3 | −32.3 | −41.0 | −15.7 | −11.0 | −125.3 |
| 1897 | −25.5 | +25.3 | −24.7 | +11.8 | −15.5 | −12.6 | − 41.2 |
| 1898 | −20.2 | −11.0 | − 9.8 | −16.5 | −24.8 | −27.2 | −109.5 |
| 1899 | −17.8 | −12.7 | −14.3 | −22.9 | −11.2 | −13.7 | − 92.6 |
| 1900 | − 5.5 | − 8.7 | −13.1 | −15.9 | + 6.4 | +10.8 | − 26.0 |
| 1901 | +54.9 | −10.4 | +30 9 | +45.9 | +15.9 | −18.5 | +118.7 |
| 1902 | + 0.9 | −11.1 | − 2.7 | −11.7 | + 2.6 | −13.4 | − 35.4 |
| 1903 | + 2.5 | − 4.5 | + 6.0 | +13.3 | 0.0 | +16.0 | + 33.3 |
| 1904 | + 2.4 | +24.8 | − 5.0 | −18.3 | − 7.3 | − 3.7 | − 7.1 |
| 1905 | − 8.5 | − 1.7 | −13.9 | + 9.4 | −11.8 | +13.8 | − 12.7 |
| 1906 | −14.1 | −14.3 | − 9.5 | −10.9 | + 3.8 | − 2.1 | − 47.1 |
| 1907 | + 6.4 | + 9.8 | +23.3 | + 5.8 | +13.3 | + 4.1 | + 62.7 |
| 1908 | +19.7 | +13.6 | +27.8 | +20.5 | −15.1 | −14.9 | + 51.6 |
| 1909 | + 9.8 | +18 0 | + 6.6 | − 9.7 | − 4.2 | +33.1 | + 53.6 |
| 1910 | −13.1 | + 3.8 | −11.4 | − 7.2 | + 7.4 | +33.3 | + 12.8 |
| 1911 | + 7.2 | 0 0 | +13.3 | +32.8 | +22.9 | −17.4 | + 58.8 |
| 1912 | −19.4 | −14.7 | −21.2 | −16.7 | − 1.3 | + 9 6 | − 63.7 |
| 1913 | + 9.9 | −12 2 | − 6.0 | +13.5 | + 0.6 | +12.0 | + 17.8 |
| 1914 | − 2.1 | + 7.1 | + 3.9 | −19.8 | −12 0 | −37.3 | − 60.2 |

TABLE V. — INDEX NUMBERS OF COAL AND PIG IRON

| Year | Percentage deviations from secular trend | | Combined index numbers |
|---|---|---|---|
| | Coal | Iron | |
| 1882 | + 1.9 | + 6.5 | + 8.4 |
| 1883 | + 5.3 | − 2.0 | + 3 3 |
| 1884 | + 3 3 | −18.5 | −15.2 |
| 1885 | −10.8 | −25 9 | −36.7 |
| 1886 | −13.2 | 0.0 | −13.2 |
| 1887 | − 2.9 | + 7.8 | + 4.9 |
| 1888 | + 6.8 | + 3 0 | + 9 8 |
| 1889 | − 1.3 | +15.7 | +14.4 |
| 1890 | + 5.1 | +32.4 | +37.5 |
| 1891 | + 8.6 | +11.4 | +20 0 |
| 1892 | +10.6 | +16.7 | +27.3 |
| 1893 | + 6.7 | −14.6 | − 7.9 |
| 1894 | − 5.3 | −26.0 | −31.3 |
| 1895 | + 1.0 | − 1.9 | − 0.9 |
| 1896 | − 6.5 | −17.1 | −23.6 |
| 1897 | − 8.8 | −13.4 | −22.2 |
| 1898 | − 5.7 | − 2.3 | − 8.0 |
| 1899 | + 0.8 | + 4.3 | + 5.1 |
| 1900 | 0 0 | − 2.7 | − 2.7 |
| 1901 | + 0.7 | + 4.9 | + 5.6 |
| 1902 | − 3.7 | + 9 1 | + 5.4 |
| 1903 | + 6.9 | + 2.7 | + 9.6 |
| 1904 | − 2.1 | −12.4 | −14.5 |
| 1905 | + 3.0 | +14.4 | +17.4 |
| 1906 | + 1 9 | +18.3 | +20.2 |
| 1907 | +11.6 | +13.6 | +25.2 |
| 1908 | − 8.4 | −33 6 | −42.0 |
| 1909 | − 3.6 | + 2.2 | − 1.4 |
| 1910 | + 0.8 | + 3.5 | + 4.3 |
| 1911 | − 4.4 | −13.9 | −18.3 |
| 1912 | − 0.4 | + 4.3 | + 3.9 |
| 1913 | + 3.1 | + 5.4 | + 8.5 |